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HERITABILITY AND GENETIC TREND ESTIMATES FOR TRAITS MEASURED ON STATION-TESTED BULLS

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Bulls have been evaluated at Ontario test stations over almost 20 years on the basis of average daily gain (ADG) on test for purposes of selecting them as herd and AI sires. In recent years, various measurements of these bulls have been taken at the end of the 140-day official test period: fat thickness measured ultrasonically, height at the hooks, and scrotal circumference. These values are reported as measured and can also be considered in selecting bulls.

The genetic response to selection for any given trait depends on several factors. The heritability, intensity of selection, interval between generations, and type of selection strategy, that is, single versus multiple trait selection, will all affect the response. The heritability of a trait may help to determine whether or not it is worthy of being included in a selection programme.

In a situation where actual selection pressures are not known, such as is the case with beef cattle in Ontario, it is useful to have estimates of genetic progress for some associated subpopulation such as bulls on test. Estimates of this type help to determine the success and effectiveness of established selection programmes.

OBJECTIVES OF THE STUDY

The specific objectives of this study were:

1. to estimate heritabilities by breed for traits measured on tested bulls; and;
2. to estimate genetic progress within the population of tested bulls for each combination of breed and trait.

DATA AND METHODS

Data used came from bulls which were 7/8 or more Aberdeen Angus, Charolais, Hereford, Limousin, Shorthorn, and Simmental tested in Ontario and Manitoba stations between 1970 and 1985. Where possible, bulls were matched with records of average daily gain to weaning from the Federal-Provincial Herd ROP Program.

Sire and error components of variance for traits measured on test were estimated using various modifications of a model. This included the effects of test group, age of the animal at the end of test (linear and quadratic), and the additive genetic value.

Preliminary analysis of ADG on test showed that neither the linear nor the quadratic effects of the age of the animal at the end of test was significant. Only the linear term was significant in the analysis of fat thickness and scrotal circumference, but both were significant in the analysis of height. Models were constructed accordingly.

For the analysis of ADG to weaning, the fixed effect of the test group was replaced by the fixed effect of herd year. The end-of-test age covariates were replaced by age at weaning. Both the linear and quadratic terms were significant.

Each breed was analyzed separately for all traits, and heritability estimates were obtained from the sire and error variances. Heritability is essentially an estimate of the fraction of the total observed variance which is heritable.

Breeding values were obtained for each bull for each trait using Best Linear Unbiased Prediction (BLUP). A regression of BLUP-derived estimated breeding values (EBV's) on the year of birth yielded estimates of genetic progress.

SUMMARY OF RESULTS

Table 1 shows the breed means for the various traits measured. All traits were found to be relatively highly heritable, as can be seen in Tables 2 and 3. Selection for one or a combination of these traits, therefore, is a realistic goal.

Heritabilities differ significantly between breeds, however, for both pre-test and on-test ADG. The exotic breeds, Charolais, Limousin, and Simmental, had lower heritabilities for ADG to weaning than did the British breeds. Limousin and Simmental bulls also showed low heritabilities for ADG on test. These results may reflect a lesser amount of variability among sires of these breeds.

Regardless of the cause, low heritabilities can adversely affect the degree of genetic response to any given selection programme. Because of high standard errors, heritability estimates for the secondary traits are given as weighted averages pooled across breeds.

Estimates for genetic progress were low for all combinations of breed and trait (Table 4); there were no trends of significance for the Limousin. Trends for both measurres of ADG and height were generally positive. The trends in ADG to weaning would correspond to changes in a 200-day weaning weight of between 0 lbs per year for Limousin and 1.5 for Shorthorn. Trends for test station ADG would correspond to changes in absolute gain from weaning to yearling of up to 1.3 lbs per year for Shorthorn.

For fat thickness, trends for the exotic breeds were generally positive, but those for Hereford and Angus were negative. This implies that patterns for fattening and a reduction of the variability between breeds for fat thickness converge.

Common selection goals should not necessarily be pursued for all breeds. The above results suggest that selection in all breeds is towards an optimum end for market finish. The need for complementarity rather than similarity in breed types emphasizes the importance of crossbreeding in beef.

Effective selection programmes should result in genetic changes of 1% of the population mean per year in a population with natural service. Use of artificial insemination, increasingly prevalent in the Ontario industry, would increase the level of response which could be expected.

Trends observed in the bull-test population, however, were about 0.1% to 0.5% of the population mean per year. Obviously, such low levels are a cause for concern. Given the relatively high heritabilities estimated for these traits, much greater response levels would be expected from effective selection programmes. The low responses may reflect problems with the information available for use in selection procedures or with the application of such information.

The values reported for secondary traits are raw phenotypic ones. A calculation of some genetic values for these would improve selection results. Likewise, efforts are underway to improve the ROP index so that it reflects more accurately the genetic worth of animals for growth rate.

Improvements such as these in the information available could increase genetic response to selection pressures. Nonetheless, the onus is on the producer to develop effective breeding strategies and apply long-term selection pressure toward set goals. The design of breeding programmes may, and should, vary among breeds and breeders.

Table 2: Heritabilities for growth rates by breed

BREED	ADG TO WEANING	ADG ON TEST
Aberdeen Angus	.23	.46
Charolais	.08	.55
Hereford	.32	.54
Limousin	.17	.22
Shorthorn	.54	.38
Simmental	.15	.20
Weighted Average	.25	.44

SIGNIFICANCE OF THESE RESULTS TO THE INDUSTRY

The knowledge that traits measured on performance-tested bulls are relatively highly heritable supports attempts to select for superior animals on the results from test stations. The low level of trends in response to the selection strategies of producers which has been observed to this point is disappointing, but does indicate the need for carefully planned and effective selection programmes with clearly defined, long-term goals. With an improvement in the statistics available for use in the selection of animals and in the selection strategies of breeding associations and breeders, the genetic response of the Ontario beef cattle population to selection could be greatly enhanced.

Table 3: Heritabilities of secondary traits

TRAIT	WEIGHTED AVERAGE (1) ACROSS BREEDS
Height at hooks	.85
Fat thickness	.49
Scrotal circumference	.53

(1) Insufficient numbers of observations prevented estimation of heritabilities on a within-breed basis.

Table 1: Breed means

BREED	ADG TO WEANING (KG/DAY)	ADG ON TEST (KG/DAY)	HEIGHT AT HOOKS (CM)	FAT THICKNESS (MM)	SCROTAL CIRCUMFERENCE (CM)
Aberdeen Angus	.88	1.36	120.3	6.8	34.3
Charolais	1.11	1.67	130.6	3.5	34.2
Hereford	.82	1.37	120.9	6.4	34.3
Limousin	.99	1.53	127.9	3.0	30.6
Shorthorn	.75	1.38	123.4	6.1	35.4
Simmental	1.10	1.68	133.9	4.2	37.3

Table 4. Genetic progress estimates, per year, for each breed and trait

BREED	ADG TO WEANING (KG/DAY)	ADG ON TEST (KG/DAY)	HEIGHT AT HOOKS (CM)	FAT THICKNESS (MM)	SCROTAL CIRCUMFERENCE (CM)
Aberdeen Angus	.0017	.0024	−.698	−.078	−.093
Charolais	.0005	.0025	.388	.054	.006NS
Hereford	.0022	.0023	.114NS	−.029	.009NS
Limousin	−.0008NS	−.0001NS	.249NS	.023NS	.029NS
Shorthorn	.0034	.0036	.559	.071	.151NS
Simmental	.0005	.0007	.423	.021	.021NS

NS = not significant. This implies that the estimated trend is not significantly different from zero, and consequently, no progress is considered to have occurred. The significance of a given estimate is a function of the numbers of observations available and the variability within the data, not only of the absolute value of the estimate.

NOTE: Absolute gains can be computed by multiplying ADG to weaning by 200 days and ADG on test by 165 days. To convert to Imperial units (pounds) multiply by a factor of 2.2 lbs/kg.